

**REPORT OF THE  
NATIONAL SPATIAL DATA INFRASTRUCTURE  
MEASURES OF PROGRESS WORKSHOP**

**January 21 - 23, 1998  
Kansas City, MO**

by

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for

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The views, opinions, and/or findings contained in this report are those of the author and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

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## **ABSTRACT**

### **NSDI Measures of Progress Workshop**

This workshop was convened by the FGDC to consider the question "How do we know how we are doing at building the NSDI?" Participants represented diverse perspectives on GIS and NSDI. The NSDI was understood as a broad-based effort to improve data sharing and use. The purpose of NSDI is to get usable geospatial data into the hands of citizens and decision makers.

Participants in the engaging, productive workshop clarified the benefits of using GIS and NSDI and examined critical issues relevant to measurement, promotion, and spread of NSDI. Based on their own experience, they identified the indicators of success implicit in actual data-sharing practice. They then developed those indicators into drafts of three approaches to measuring progress in building the NSDI.

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**OVERVIEW**

This workshop was convened by the FGDC to consider the question "How do we know how we are doing at building the NSDI?" It was attended by 19 participants representing diverse perspectives on GIS and the NSDI. This engaging, productive event was a success as a result of the participants' willingness to contribute, listen, and think collaboratively about mutual interests from their distinct perspectives. These outcomes were achieved:

1. Identified indicators of success implicit in actual data-sharing experiences.
2. Clarified benefits of using NSDI and GIS.
3. Drafted three approaches to measuring progress in building the NSDI.
4. Examined critical issues relevant to the promotion and dissemination of NSDI.
5. Prioritized action steps for further development of this work.

The workshop agenda, Appendix A, was developed by Kathy Covert and John Moeller of the FGDC with significant input from an Advisory Committee and assistance from the facilitator, Lonnie Weiss. Participants were nominated by Advisory Committee members. See Appendix B for the participant roster and Appendix C for a list of Advisory Committee members.

Individuals and organizations left the workshop making commitments to further action. Priority actions include creating a group mailing list for ongoing communication, convening a stakeholder group to further develop measures, having organizations create NSDI-compliant nodes, and writing articles for non-technical journals to broaden awareness of GIS and NSDI.

Details from workshop sessions follow. Included are:

- Synthesis of critical strategic issues
- Metaphors that shed light on NSDI
- Themes that characterize successful data-sharing
- Benefits of NSDI participation

Measuring progress of NSDI: Three approaches  
Measurement development needs  
Action priority list  
Appendices

## **SYNTHESIS OF CRITICAL STRATEGIC ISSUES**

There is no question that NSDI is a good thing. NSDI is about improving data sharing and use, so citizens, communities and governments can easily make use of place-based data to solve problems. Developing technical practices such as standards and metadata is not simple. But ultimately these are simply behind-the-scenes means to an end. **The purpose of NSDI is to get usable geospatial data into the hands of citizens and decision makers.**

**GIS can help with policy development** at local, state, national and tribal levels. The general public and elected and other public officials are aware of the problems facing their communities, from public housing to teen pregnancy to land use planning. But the public and officials don't usually know about GIS and how it can help them with their problems. GIS professionals, who also happen to be citizens in their communities, are the people who can make the connections.

**A promising strategy** emerged that can help build the national spatial data infrastructure. **Identify non-traditional potential users of GIS; demonstrate the value of GIS and NSDI** to their local decision making, policy development, and civic applications; **and enlist these new champions' support** for NSDI activities. The logic for this strategy follows.

A major problem is that localities (cities, counties, tribes, states) face economic barriers to participation in NSDI. Some face the initial hurdle of acquiring equipment and getting basic access to electronic geospatial information. For those that have already made an investment, another economic barrier appears: What is the incentive to go beyond their immediate data needs and put the data in a sharable format? What is the basis for enlightened self-interest and perceiving the mutual benefit of NSDI participation? And how can the bottom-line impact be understood?

Two keys to convincing people to invest in GIS are demonstrating its value and benefit, and engaging champions to further the effort.

This strategy to promote GIS and NSDI focuses not on GIS but on community issues, the problems that NSDI can help solve. GIS professionals can recognize real life problems that GIS and NSDI can benefit. Identify these policy issues and the people who are working on solutions. Offer GIS information and work with these people to support the problem solving process and to reach solutions. When they appreciate the

demonstrated value and benefits of using GIS, public officials and elected officials may become champions of further investment in NSDI.

Another critical strategic issue, a barrier for Tribal government participation in NSDI, is the **fear that Tribally developed data can be used against them**, based on historical and current experiences. The misuse of data has become a question of survival for some tribes and counties. Gain or loss is usually measured in dollars, but land and the survival of a lifestyle are more significant indicators in other cases. Even with trusting and trustworthy relationships it may be difficult to establish full participation with NSDI.

The existence of a "**PSDI**", a **private spatial data infrastructure**, was also acknowledged. Hopefully future conversations about NSDI development and measures of progress will attract more private sector participants. Issues to explore include exploring the role of the commercial sector in developing the NSDI and identifying the benefits of involvement to them so that the private sector is fully participating in the NSDI.

## **METAPHORS THAT SHED LIGHT ON NSDI**

Three metaphors emerged that may be useful in both understanding what NSDI is and does, and in developing creative and meaningful indicators of progress.

**The Interstate Highway System Metaphor.** Ann Azari introduced the metaphor of the development of the Interstate Highway System. Photographs from the construction years show segments of road that simply ended and didn't connect anywhere. The NSDI is similarly incomplete today. And naturally, there were roads that worked before the interstates. But a national level decision was made to invest in improving the transportation system, and the federal government provided financial incentives to upgrade. Playing with a comparison of NSDI development and highway system construction, we could imagine quantifying losses due to incompleteness. How many data or information transports are lost due to falling off incomplete segments of NSDI? How much flawed national decision making is due to gaps in the system? How much data disappears.... into virtual reality?!

**The Library Metaphor.** Harlan Onsrud has developed the metaphor of the NSDI as a university library system or a public library system. Each node can be thought of as a branch library, with access to an interlibrary loan system. This metaphor lends itself to considering measures of success for NSDI comparable to library measures. Many things can be counted as indicators of presence and use. Other things can be assessed in terms of social impact, such as enhancing learning, democratizing decision making, and providing equitable access. See Appendix E for further detail on this metaphor.

**The Internet Metaphor.** The NSDI can be compared to the Internet. Both are systems in which technical underpinnings provide a foundation for non-technical applications. The Internet started with "techies" and depends on technical languages such as HTML, but it has grown into broad use by many people who neither want nor need to understand the technical basis. GIS and NSDI have been the realm of geographic and cartographic experts well-versed in the technicalities of their professions. The underpinnings of NSDI remain under development and are essential for the system's growth. But like the Internet, growth of the NSDI will move the technical basis into the background as non-technical users and applications move to center stage.

## **THEMES THAT CHARACTERIZE SUCCESSFUL DATA SHARING**

Participants exchanged true-life stories of successes and failures in their attempts to share data and related collaborative activities. They represented a wide variety of perspectives and sectors, yet there were themes that carried across the diverse stories. These elements form a pattern characteristic of success:

### **Mutual benefit**

Gather people around a shared, critical problem or a triggering event.  
Define the issue appropriately; it may not be a technical issue, it may be a governance, funding, or service system institutional issue.  
Lack of funding can be a stimulus for building partnerships.  
People learn through experience, colleagues, training and education.

### **Incentives**

Carrots are more important than sticks.  
Incentives are necessary for buy-in.  
The benefits must be perceived as greater than the costs.

### **Champions**

High level champion or champions are critical.  
Management must be convinced, to secure resources.  
One way to convince is to document benefits, through stories from other places or through local small scale prototypes.

### **Partnership & Inclusiveness**

Partnership can be a survival technique, and it may become an organizational way of life.  
Personal relationships are key.  
Agreements cannot exist without trust.  
You must have dialogue, with a broad base of involvement, to reach consensus.

### **Data**

You must have electronic geospatial data before you can share it.  
A data repository is necessary.  
Multiple trusted data sources are important.  
Visuals animate meaning, can illustrate the issues effectively to persuade (the Disney effect.)

## **BENEFITS OF NSDI PARTICIPATION**

The benefits of improved access, sharing and use of geospatial data are many. They include:

- Dollar efficiency with future cost avoidance
- Increased economic activity
- Improved agency and organization support
- Better management of land and actions affecting the community
- Enhanced public access to data and information
- Demonstration of accomplishments to each participant's constituency
- Improved public image for all participants -- maximizing resources, being efficient, effective, equitable
- Newly developed network of “champions” established
- Broader sense of community (seeing commonalities)
- Mutual benefits of education and communication
- Positioning participants as providers of facilitation, communication & trust building within the community
- Increased use of geospatial data and technology by organizations that have not traditionally used them
- Growth and expansion of resources, capabilities, knowledge base beyond the primary requirement
- Decision-making methods established which are convincing and can be replicated
- Increased respect and trust among all players
- Increased willingness to cooperate and share again in the future

## MEASURING PROGRESS OF NSDI: THREE APPROACHES

Workshop participants formed three small groups to draft measurement instruments that might be used by practitioners themselves or by national level organizations to assess progress in building an effective national spatial data infrastructure. Three approaches to measurement emerged.

**Approach A: Objective Measures**, identifies measurable indicators that can be counted now and into the future. These data would not be cost prohibitive to collect, and the measures are meaningful indicators of NSDI presence and activity. When refined, such indicators could form the basis of an assessment and an annual progress report through national level organizations that are partners in the NSDI.

**Approach B: Components of Success**, identifies seven components of success critical for an organization to plan and carry out NSDI-oriented activities. Short-term indicators and long-term indicators are given for each component. These components form the basis of a self-assessment tool that cooperating organizations can use independently.

**Approach C: Sustaining Systems**, identifies the efforts required of people and organizations to sustain these ventures over time. Though every item may not be necessary to sustain and nurture each unique system of relationships, this list provides a guide to cultivating their growth.

All three approaches are grounded in reflection of people's direct experience in practice. What remains to be done is refinement and testing of the methods.

### Measurement Approach A: Objective Measures

Objective, measurable indicators of how we are doing at building the NSDI overall could form the basis for national "report cards." These are the top-rated indicators of a brainstormed list of 32 ideas. (See Appendix D for the full brainstormed list.)

1. Number of clearinghouse nodes
2. Number of NSDI documented data sets
3. Number of data sets meeting all standards -- Technical & Metadata [long-term]
4. Number of agencies with written data sharing agreements
5. Number of students annually receiving education in geographic information sciences
  - a. Degrees from institutions of higher learning
  - b. GIS certifications
  - c. K-12 school districts with GIS curricula
6. Annual dollar amount of geographic information software sold
7. Number of vendors using Open GIS specifications

8. Number and location of counties using GIS at some specified level X
9. Number of data offerors by type (e.g., governmental jurisdictions)
10. Number of organizations using GIS

### **Measurement Approach B: Components of Success**

Short-term (A) and long-term (B) components of success in accessing, sharing and using geospatial data. This approach could form the basis of a self-assessment tool.

1. Are cooperative groups formed?
  - A. Are they operational?
  - B. Are there formal agreements?
2. Are all interests of the community involved (inclusiveness)?
  - A. Core group
  - B. All
3. Is there an educational outreach program established?
  - A. Sharing experience
  - B. Ongoing education needs response
4. Are standards being used?
  - A. Local/"Doable" standards
  - B. Universal standards
5. Are compliant Nodes/Clearinghouses established?
  - A. Local/community
  - B. Networks
6. Is there a coordinated ongoing effort or strategy for funding?
  - A. Ad-hoc efforts
  - B. Standard business practice
7. Are there instances of people confronted with a land-related problem that are able to find and draw on geodata they need?
  - A. Sometimes
  - B. Almost always

### **Measurement Approach C: Sustaining Systems**

Communities can draw from this list as a model, a guide to cultivating the growth of a dynamic system of relationships among people and organizations to sustain successful ventures over time.

What does it take to sustain people and organizations over time? A healthy dose of these things:

Champions at all levels

Technical savvy -- a recognition of the need for it, and how to find it

Key factor: GIS must serve the organization's mission

Political support

Feedback from constituents

-- Responsive to the needs of the constituents

-- Flexible, changes over time

Large pool of volunteers

Stable source of funding

Ongoing education of different stages (entry level to advanced)

Need vision and a plan

-- Broadly to meet various needs

-- Focused so that it does not get lost

Focus on areas of common interest, the intersection rather than the disjoint set

Getting the information out to the larger community.

Be sure to have accomplishments, achievable, short term goals

Learn from mistakes, your own and others'

Periodic post-mortem of projects

-- Among peers

-- How would you do things differently

-- "Clearinghouse" of project experience

Instilling pride in accomplishment

Integrity and trustworthiness

Periodic review of organization mission and objectives

Apply good business practice

Regularly scheduled dialogue among all constituents

Incentives for participation; ways of getting people from all parts of state/region to travel to conferences

Effective, supportive vehicles for forming partnerships

Administrative mechanisms (financial, restrictions cost-share, other administrative barriers)

Ensuring relationships are mutually beneficial

Facilitating program dialogue among different organizations  
(missions, objectives)

Coordinating councils should be representative

Individuals members of councils should be respected in their communities

Be ruthless -- eliminate what does not work  
KISS -- "Keep It Simple....."

### **MEASUREMENT DEVELOPMENT NEEDS**

All the measures, and particularly the objective count indicators, will need more attention and refinement before they are ready for testing and broad use. FGDC will convene a group of stakeholders to develop a strategy to involve the members of stakeholder organizations in further developing these measures. Workshop participants identified these measurement development ideas:

- Clean up the draft metrics generated at the workshop. A list of "Clean Up Metrics" actions was generated and prioritized. See Appendix G for this full list.
- Developing a Survey tool came up several times. There are significant construction and quality issues in creating and administering any survey. The thought was to focus on the existing customer/user base. Use of the Internet was brought up.
- Certification of communities, agencies, or organizations that are "doing NSDI" was suggested. Note that there are potential complicating implications of this strategy and be sure to weigh them carefully.
- Add a question to Census about GIS/NSDI (? Not an easy thing to do!)
- Count the number of counties/government units that have GIS.
- Develop a GIS Report Card covering Federal/state/local jurisdictions.
- Encourage self reporting.
- Look more closely at reports of NSDI program grantees; extract implicit measures.
- Search and report on spatial data available through clearinghouse (maybe focus on framework?)
- Library metaphor as stimulus for measurement ideas. See Appendix E.

## **ACTION PRIORITY LIST**

Organizers and participants thought it was important to leave the workshop with concrete outcomes and steps that individuals can act on, in addition to organizing further shared work. Participants brainstormed 59 possible actions loosely categorized as Individual Actions, Actions to Clean-Up Metrics, and Organizational Actions. Items were then evaluated on two dimensions, impact and ease of implementation ("meaningful and doable") to arrive at priorities for action. Twenty-five items received one or more 'votes'; see Appendix G for the full list and the number of votes received. The following items were top priorities; they each received 5 or more votes.

### **Individual Actions**

Write articles that entertain or incense in non-technical journals  
More education re: NSDI  
Use the Framework Handbook well

### **Clean-Up Metrics Actions**

Examine existing metrics  
Coordinate with organizations that touch a broad spectrum of people, such as State Geographic Councils, Associations of Counties, Municipal Leagues, Tribal leaders

### **Organizational Actions**

Whenever you do a partnership agreement, put NSDI element in it to prompt inclusion of these issues; make it part of the partnership agreement process  
Use our organizations to create NSDI-compliant nodes

### **FGDC Commitments:**

The FGDC will take a facilitation role in convening the national stakeholder organizations to take ownership of fleshing out the indicators. Sharing responsibility for developing and implementing key indicators is in the interest of stakeholder groups and it is a way to have impact in the national community.

FGDC will will provide the Framework Handbook to workshop participants.

A Coordination/Partnership Handbook is being developed. FGDC and NSGIC representatives will work together to ensure that NSDI elements in partnership agreements are included.

FGDC will provide a group mail list to support ongoing communication among workshop participants, many of whom expressed interest in updates on how actions are progressing. As soon as possible, the intention is to open up that list to anyone interested in participating and contributing to this effort.

## **LIST OF APPENDICES**

- A. NSDI Measures of Progress Workshop Agenda
- B. Participant Roster
- C. Advisory Committee Members
- D. Measurable Indicators
- E. Library Metaphor
- F. Candidate NSDI Measures of Progress
- G. Action Steps: Full Brainstormed List

**APPENDIX A.**  
**NSDI Measures of Progress Workshop AGENDA**

**Workshop Purposes**

- Agree on assumptions about what NSDI means
- Identify implicit indicators of success in building NSDI
- Develop indicators of progress that can be tested and used broadly
- Plan next steps to spread use of indicators of progress

**DAY 1      Wednesday      January 21, 1998**

8:15      Continental Breakfast, Informal Gathering  
9:00      Open the Workshop  
9:45      What Do We Mean by NSDI?  
12:00      LUNCH  
1:45      Data Sharing Story  
2:15      Small Group Story Telling & Focused Listening  
4:30      Reports from Small Groups  
5:00      End Day 1

**DAY 2      Thursday      January 22, 1998**

8:30      Welcome & Agenda Review  
8:40      Discussion: More on the Meaning of NSDI  
10:15      Small Groups: Drafting Indicators Checklists  
12:00      LUNCH  
1:30      Reports from Small Groups  
2:00      Small Group Work: Testing the Drafts  
4:00      Reports and Discussion  
5:00      Close Day 2

**DAY 3      Friday      January 23, 1998**

8:30      Open the Day  
8:45      Summary: Where Are We Now?  
9:45      Planning Next Steps  
11:00      Discussion: Strategic Direction  
11:45      Evaluate and Close the Workshop

**APPENDIX B.  
PARTICIPANT ROSTER**

|                  |   |                           |
|------------------|---|---------------------------|
| Eric Anderson    | City Manager  | Des Moines,<br>Iowa       |
| Ann Azari        | Mayor   | Fort Collins,<br>Colorado |
| William Burgess  | Geographic Information Services Director,<br>Maryland Dept. of Natural Resources                    | Annapolis,<br>Maryland    |
| Kathy Covert     | FGDC Staff  | Reston,<br>Virginia       |
| William J. Craig | Assistant Director for Research,<br>Center for Urban & Regional Affairs,<br>University of Minnesota | Minneapolis,<br>Minnesota |
| Richard Friedman | GIS Coordinator, McKinley County  | Gallup,<br>New Mexico     |
| Randy Fusaro     | Geographer, Census Bureau   | Washington,<br>D.C.       |
| Richard Hager    | GIS Coordinator,<br>Natural Resources Conservation Service  | Salinas, Kansas           |
| Jono Hildner     | Chair, NACo Information Technology<br>Subcommittee  | Oregon City,<br>Oregon    |
| Sandy Majewski   | Research Scientist, SAIC  | Las Vegas,<br>Nevada      |
| John Moeller     | FGDC Staff Director   | Reston,<br>Virginia       |
| Marilyn Myers    | Assistant Chief, USGS-NMD-RMMC  | Denver,<br>Colorado       |
| Bill Northover   | Chairman, Intertribal GIS Council   | Pendleton,                |

|                  |   |                           |
|------------------|---|---------------------------|
| Harlan Onsrud    | Associate Professor, University of Maine            | Oregon<br>Orono,<br>Maine |
| David Painter    | FGDC Staff  | Reston,<br>Virginia       |
| J. Milo Robinson | State Geodetic Advisor,<br>National Geodetic Survey | Montpelier,<br>Vermont    |
| Donica Sharpe    | Addressing Coordinator, San Juan County             | Aztec,<br>New Mexico      |
| CloAnn Villegas  | Treasurer, Intertribal GIS Council                  | Pablo, Montana            |
| Darryl Williams  | Cartographer, USGS-NMD                              | Rolla, Missouri           |

**APPENDIX C.  
ADVISORY COMMITTEE MEMBERS**

The following people generously gave their time and engaged with FGDC staff to help create the agenda and design for the January NSDI Measures of Progress Workshop. This Advisory Committee met for one full day meeting and they submitted nominations to get broad participation at the January workshop.

|                  |   |
|------------------|---|
| Ann Azari        | Mayor, Ft. Collins, Colorado                                    |
| Bill Burgess     | Department of Natural Resources, State of Maryland              |
| William Craig    | Center for Urban & Regional Affairs, University of Minnesota    |
| Donica Sharpe    | Addressing Coordinator, San Juan County, Aztec, New Mexico      |
| F. Michael Smith | Principal, F. Michael Smith and Associates, Oakland, California |

## APPENDIX D. MEASURABLE INDICATORS

This is the full list of indicators as brainstormed by one sub-group of workshop participants. Items are coded by the summary categories Internet, Partnership, Education, Vendor, Usage. Note that this list and the sorting categories are **first drafts**. The top 10 indicators appear in the body of this report in the section Measuring Progress of NSDI: Three Approaches.

1. I # of hits on a Web site
2. I # of Clearinghouse nodes
3. P # of agencies with written GIS data-sharing agreements
4. P # of agencies without written agreements
5. U Breakout #'s by types of data offerers (city, county, state, tribal, federal, private)
6. U # of data offerers by type
7. I # of NSDI-documented data sets
8. U Budget dollars expended on annual basis; by infrastructure, by data development
9. U # of GIS users
10. V # of licenses
11. U # of organizations using GIS
12. V # of GIS hardware/software
13. U # and location of counties that have GIS at X level: # of data sets? by framework?
14. U/V Break out users by CAD, PC, UNIX...
15. V Map of every license held: from each major vendor? from all vendors?
16. E # of trained GIS staff
17. U % of problems that need geographic data you are able to find data for
18. U List of types of uses (types of problems solved)
19. V # of decision support applications
20. U # of articles or case studies representing first application of GIS in a field
21. P/E % of elected officials who understand GIS and NSDI
22. V \$ of sales of GIS-applied applications/decision support software, by location
23. V Vendor use of Open GIS specifications
24. E # of workshops on GIS/NSDI at conferences of elected/ public officials, administrators
25. E # of attendees at such workshops
26. E # of students from institutions of higher education with degrees or specialties in GIS
27. E # of graduates with GIS degrees
28. E # of certifications given for GIS

- 29. E # of K-12 school districts with GIS curricula
- 30. I # of data sets meeting all standards, technical and metadata
- 31. I # of clicks to get to where you want to get on the Internet
- 32. I/V # of common Internet Service Providers (AOL, Microsoft, browsers...)  
including a package for Clearinghouse software

## **APPENDIX E.**

### **LIBRARY METAPHOR**

Harlan Onsrud's metaphor of the NSDI as a library lends itself to considering the measures used to gauge the success of a library or library system, and imagining the corresponding measures for NSDI and sharing data. Examples include:

- Number of volumes
- Number of patrons, density of patrons
- Comprehensiveness of collections
- Stability of funding
- Variety of collections
  - federal depository
  - state collections
  - private publisher books
- User satisfaction
- Extent of access to other libraries
  - university/public/private/government
- Quality of card catalogue/search engine
- Quality of collections
  - Trash novels
    - high use, higher entertainment value
    - low economic development value
    - low science advancement value
  - Scientific collections
    - low use, low entertainment value
    - high economic development value
    - high science advancement

The suggestion is to look at all data currently published for federal, state, local and university libraries and find out comparable measures for geographic information system operations. Some measuring could be done on-line electronically and automatically through an on-line questionnaire with completion voluntary, but with strong incentives. For instance, an incentive might be an annual published report on the status of GIS operations nationwide, with complimentary copies shipped to all governors, heads of state legislatures, major university libraries and all respondents.

Harlan suggests that some measures will be pragmatic assessment through counts or surrogates. These would look at information system success and could be sought in organizational literature. Other measures will look at indications of social impact of local libraries, an entirely different process. This would address questions such as: has it enhanced learning?; has this enhanced democratization of decision-making (Jeffersonian Principle)?; does it provide equitable access to all? He suggests that we don't even ask these questions anymore for public libraries; they are now assumed to

achieve similar results.

## **APPENDIX F. CANDIDATE NSDI MEASURES OF PROGRESS**

Cliff Kottman, Open GIS Consortium, was unable to attend the workshop. However, he contributed this list of possible measures.

1. Number of federal government geospatial clearinghouse servers and quantity of information served
  - More servers and information indicates growth of the NSDI
  - Need to distinguish "file" servers from "query" servers
  - Need metrics on volume of information served
  - Need metrics on percent of geospatial information now accessible
2. Number of hits on federal government geospatial clearinghouse servers
  - More hits indicate more mature NSDI
  - Need to distinguish "successful hits" from "attempts"
  - Need assessment of user satisfaction
3. Number of commodity geospatial information vendors and their total sales volume
  - More information vendors indicates a more mature NSDI
  - Need to distinguish "file" vendors from "query result set" vendors
4. Number (and "inches") of infrastructure-centric advertisements in GIS World and other geospatial-centric magazines
  - More geospatial "middleware", and more competition for it, indicates a maturing NSDI
  - Need to categorize infrastructure middleware "niches"
  - Need metrics on sales quantities and frequency of middleware employment
5. Maturity of municipal spatial data infrastructures
  - Need metrics on "maturity"
  - Integrity of parcel, street, and utility geometries
  - Integrity of multi-scale information
6. How much are municipalities spending on geospatial data
  - Accounting principles that make this an easy question indicate a maturing NSDI
  - How much for collection
  - How much for maintenance
  - How much to make geospatial data more responsive to queries

7. How much are citizens spending on geospatial data
  - In taxes
  - In utility and telephone bills
  - In other ways
  - Accounting principles that make these questions easy indicate a maturing NSDI
  
8. To what degree are municipalities coordinating geospatial information across many departments
  - What departments are sharing data/information/processes
  - How much savings are generated by sharing
  - How much could municipalities save by coordinating more seriously
  - Accounting principles that address these questions indicate a maturing NSDI
  
9. Number of cities that have a municipal spatial data clearinghouse server
  - A larger number indicates a more mature NSDI
  - Need to distinguish "file" services from "query" services
  - Need metrics on volume of information served
  - Need metrics on percent of geospatial information now accessible
  
10. Degree of interoperability in local government geospatial operations
  - Need metrics on degree of interoperability
  - Number of lines of code in "interoperability-centered" middleware
  - Greater interoperability indicates a more mature NSDI
  
11. Degree to which we take for granted geospatial services and information access
  - Services that are "invisible" are more mature
  
12. Degree to which geospatially-based commerce is enabled or disabled
  - Percent of advertising that is geospatially enabled
  - Percent of service industry employing geospatial information
  - The number of GPS units sold outside the military
  - The percentage of cars and trucks with in-car navigation systems
  - The percentage of farm machines equipped for precision agriculture
  - The number of consumer devices, kinds of consumer devices, and revenue from consumer devices with geospatial capabilities
  
13. Degree to which enterprises employ heterogeneous geospatial platforms
  - Use of heterogeneous processing platforms
  - Use of heterogeneous software platforms
  
14. Number of on-line for-fee geospatial services on the web
  - Need to create categories of services
  - Need to create categories of fee structures

15. Number of OpenGIS conformant products in use divided by number of all geoprocessing products  
Note: a ratio of 1.0 defines a working NSDI
  
16. The ratio of "customized maps" to "standard maps"  
The number of customized maps appearing in daily newspapers and news broadcasts  
The number of customized maps appearing in grade school and high school project fairs  
The number of customized maps appearing in masters theses  
The number of customized maps appearing in city council meeting minutes  
The number of video games with virtual terrain derived from Earth data
  
17. The progress of the Open GIS Consortium  
The number of completed OpenGIS Implementation Specifications  
The number of OGC TC Domain Special Interest Groups

## **APPENDIX G.**

### **ACTION STEPS: FULL BRAINSTORMED LIST**

(Number of votes / points indicated to the right.)

#### **Individual Actions:**

1. Research project to validate indicators
2. Fully extend the library metaphor
3. Do something in high schools (early intervention)
4. Structure indicators into FGDC funding programs (1 point)
5. More education re: NSDI (6 points)
6. Learn more to help others (1 point)
7. Vote for politicians who appreciate NSDI
8. Distribute this info & perspective to the NMD field offices
9. Use the Framework Handbook well (6 points)
10. Self-assessment measures - urge use in my area (1 point)
11. Promote and educate; show it's easy
12. Educate co-workers
13. Write articles that entertain or incense in non-technical journals (7 points)
14. Tell NSGIC, other skeptics, state GIS committees: I'm no longer skeptical
15. Push harder on equity and access, get them on board (2 points)
16. Research benefits of data sharing via my state GIS (1 point)
17. Reconvene 'stakeholders' (national organizations) re: how these groups can move the top indicators forward
18. Develop a bulletin board where people can anonymously post past failures for shared learning
19. School & library systems in a community are linked; be sure there's a node on this system& that it's linked to new geography education standards (1 point)
20. Help with followup, clean-up from KC workshop
21. "Meta-fear & standards phobia": help people overcome these & appreciate need for standards & metadata (4 points)

#### **Cleaning-up/firming up metrics:**

22. Examine existing metrics (7 points)
23. Check state annual report. Are metrics close to these? Easy to modify?
24. Get Cliff Kottman -OpenGIS involvement (& his list of indicators) (2 points)
25. Hildner to work with FGDC staff on tweaking metrics
26. Get NACo's commitment to work on this with FGDC (2 points)
27. (redundant item)
28. Check the 5 categories of measurable indicators. Are they right?  
What areas to probe? (1 point)

29. Quick and dirty 1 page survey re: How you measure; distribute at conferences
30. Coordinated effort (academic community?) to use web form to consolidate surveying (1 point)
31. Don't reinvent the wheel. Coordinate among surveys, use as building blocks (e.g. NSGIC - Kansas surveys)
32. ID who, what organizations will be tracking what info. Who should accumulate the data? Gather it?
33. State Geographic Councils, Association of Counties, municipal league, tribal leaders, touch broad spectrum of people. Coordinate with these organizations (7 points)
34. Consider incentives for getting elected and public officials engaged with GIS
35. Consider appropriateness of 3 measurement approaches to different applications
36. Stratify; measure at different levels of people and organizations (Chief Information Officer, executive, management, technical staff)
37. Find out # of tribes using GIS and with trained staff
38. Find out # of tribes fighting to keep their data from BIA or states.
39. Find out if it warrants asking NSDI to help us (tribes) through the use of the executive order
40. Work on GIS implications for issues that elected and public officials are concerned about, to make a difference and to get their and buy-in

### **Organizational Actions**

41. Organizations put out a report card for their own members. FGDC also could have one on subcommittees (3 points)
42. Jono Hildner: Make sure NACo on board (meeting 2/26) - pushing this stuff through
43. IGC Conference in June: FGDC/NSDI be there! (1 point)
44. NV GIS homepage: put hot links in, get it out there many times, via state organizations
45. Organizations provide resources funding, training, workshops (2 points)
46. Offer certificate of commendation from Governor for promoting data well to others (MN model can be picked up)
47. Certification "NSDI certified participant" to give bragging rights to cities, other jurisdictions. FGDC would certify to states? (8 points)
48. Focus on technical problems (data integration tool) - NMD
49. Create a GIS affiliate to state Associations of Counties. A good way to get word out from more local (not just Federal) level. (4 points)
50. New Mexico GIC provides NSDI training for membership. Local flavor, direct experience. Workbooks available soon. (1 point)
51. IGC contact NSGIC for framework survey coordination. (1 point)

52. UCGIS put survey instrument (or tool?) on the web (for comment)
53. UCGIS plans a Congressional breakfast for Spring '98. Inform Congressional Staff re: GIS, educate re: importance
54. UCGIS summer retreat to focus on NSDI and on GIS and Society. Bringing in government and industry people to inform UCGIS's research agenda.
55. FGDC and URISA get more coordination. Use URISA as vehicle for FGDC and NSDI.
56. Use our organizations to create our own NSDI compliant nodes (5 points)
57. As organizations, point out disjoints in a friendly way when what we hear from FGDC about NSDI does not match what we see on the ground.
58. Develop interactive CD-ROM based on NMGIC workbooks (for all levels, management and technical)
59. Whenever you do a partnership agreement, put NSDI element in to prompt inclusion of these issues. Make it part of the partnership agreement process. (9 points)